S
1
A28
Vols 7-10
JAN 10 1939

AGRICULTURAL NEWS LETTER

VOL. 7 - NO. 1 JANUARY, 1939

This publication gives information on new developments of interest to agriculture on laboratory and field investigations of the du Pont Company and its subsidiary companies.

In addition to reporting results of the investigations of the Company and its subsidiaries, published reports and direct contributions of investigators of agricultural experiment stations and other institutions are given dealing with the Company's products and other subjects of agricultural interest.

DU PONT
REG. U. S. PAT. OFF.

ISSUED BY PUBLIC RELATIONS DEPARTMENT, E. I. DU PONT DE NEMOURS & CO., INC., WILMINGTON, DEL.

AGRICULTURAL NEWS LETTER

Vol. 7 - No. 1 January 1939.

Page

The High Efficiency of Low-Cost Sources of Nitrogen for Potatoes Demonstrated and Reported by Florida 1

A "Key" to Deficiencies of Essential Plant Nutrients Developed by Scientists of Department of Agriculture 4

Mosquito Abatement Versus Wildlife Preservation Studied and a Solution of the Problem Suggested 6

Experimental Work with the Introduction of Chemicals Into the Sap Stream of Trees for Control of Insects 11

An Improved Fungicide for Treating Newly Sawn Lumber to Prevent "Blue Stain" Is Expected to Effect Savings 17

#####

General

Agricultural News Letter (du Pont)
Vol. 7, No. 1, January, 1939

THE HIGH EFFICIENCY OF LOW-COST SOURCES OF NITROGEN FOR POTATOES DEMONSTRATED AND REPORTED BY FLORIDA

EDITOR'S NOTE: The following discussion is based on a recent mimeographed publication, "Potato Fertilizer Experiments," by R. W. Ruprecht and H. W. Winsor, issued by the Florida Agricultural Experiment Station, Gainesville, Florida. The experimental data seem to point the way to increased efficiency in the use of fertilizers, and clearly indicate that fertilizer costs may be reduced.

By F. W. Parker, Agronomist
Ammonia Department
E. I. du Pont de Nemours & Co., Inc.
Wilmington, Delaware.

The Florida Agricultural Experiment Station in 1929 began a series of fertilizer experiments with potatoes on Plummer fine sand, within two miles of Hastings, the center of a very important potato-producing area, and continued them through 1937.

The area was virgin soil, having been used for a preliminary experiment in 1928. All fertilizer treatments were in triplicate on 1/10-acre plots. The fertilizer was applied in the furrow, and the rows bedded for machine planting. Maine-grown Spaulding Rose were planted about the third week in January and harvested the first of May. The experiments included (1) sources of nitrogen; (2) amounts of phosphoric acid; and (3) sources and amounts of potash. The discussion here will be limited to a comparison of the different sources of nitrogen, as shown in the following table:

Acre Yields of Potatoes from 2,000 pounds of a 4-7-5 Fertilizer

Source of Soluble Nitrogen	(A) 100% Soluble Nitrogen	(B) 50% Soluble Nitrogen; 50% Organic Nitrogen	(C) 100% Soluble Nitrogen plus 150 lbs. Nitrate of Soda as Side-Dressing
	bushels	bushels	bushels
Nitrate of Soda	130.6	125.7	128.1
Sulphate of Ammonia	119.6	117.4	120.4
Urea	147.2	131.2	148.5
Leunasaltpeter	128.4	134.5	124.6

Note: The plot receiving 100% of the nitrogen from organics produced 121.0 bushels.

Continued on next page

The data in the foregoing table indicate sulphate of ammonia is the least desirable of the four sources of soluble nitrogen used in the experiment. It produced the lowest yield when used alone, with insoluble organics, or with a side-dressing of nitrate of soda. Urea, on the other hand, produced the highest yield when used alone, and with a side-dressing of nitrate of soda. It was next to highest when used with organics. Nitrate of soda and Leuna-saltpeter produced better yields than sulphate of ammonia, but somewhat lower yields than urea.

The relatively low yields secured with sulphate of ammonia are probably due to the fact that it increased soil acidity to a harmful degree. Unfortunately, the experiment did not include a fertilizer in which the sulphate of ammonia was supplemented with dolomite to make a neutral mixture. The good results secured with urea may be due to its low acidity and resistance to loss by leaching, a combination of properties not possessed by the other nitrogenous fertilizers.

A comparison of the data in Column A (all nitrogen from soluble sources) with that in Column B (50% of the nitrogen from fish meal or tankage) shows that the use of the organics reduced the yield in three of the four comparisons. This is in agreement with data from similar experiments reported from the Charleston area by the South Carolina Agricultural Experiment Station (South Carolina Agricultural Experiment Station Special Circular No. 3).

These data clearly indicate one method which many growers could adopt to reduce fertilizer costs and increase the efficiency of their fertilizers. Nitrogen in organics usually costs three to four times as much as it does in leaching-resistant, soluble sources. The data certainly indicate that a grower should not pay a premium for insoluble organics.

A comparison of Column A (all the nitrogen applied at planting) with Column C (same quantity of nitrogen at planting plus an additional side-dressing of 150 pounds of nitrate of soda) shows that there is no advantage in applying the additional nitrate of soda. The yields in comparative plots are almost identical. An initial application of nitrogen in 2,000 pounds of a 4-7-5 produced maximum yields under the conditions of the experiment.

Following completion of the foregoing experiment in 1932, another experiment was started, and conducted in essentially the same manner as the first one. The acre yields of potatoes from 2,000 pounds of a 4-7-5 fertilizer are shown in the following table, along with the calcium content and equivalent acidity of each application listed:

Continued on next page

Source of Soluble Nitrogen	Calcium Content	Equivalent Acidity	Yield, per Acre
	Per Cent		Bushels
(50% Sulphate of Ammonia			
(50% Nitrate of Soda	0	36	143.0
Cal-nitro 16%	27	24B	160.6
Calcium nitrate	27	36B	148.8
Calurea	13	22	152.0

Good yields were obtained from all sources, especially the three containing calcium. Doubtless the yield secured with the sulphate of ammonia-nitrate of soda combination would have been improved by a supplement of dolomite. The experiment did not include a comparison with organics, since the previous four years' work seemed to answer that question conclusively.

Agricultural News Letter (du Pont)
Vol. 7, No. 1, January, 1939

A "KEY" TO DEFICIENCIES OF ESSENTIAL PLANT NUTRIENTS DEVELOPED BY SCIENTISTS OF DEPARTMENT OF AGRICULTURE

EDITOR'S NOTE:- This announcement of the result of research by the United States Department of Agriculture serves to further emphasize the value of scientific investigations carried on by this agency. The publication referred to in the article -- Technical Bulletin No. 612 -- is available through the Superintendent of Documents, Washington, D. C., at ten cents a copy.

Only the plant itself can tell the whole story of what plant food is lacking in the soil in which it grows. Chemical soil tests show what elements are in the soil, but do not, as a rule, give an accurate measure of how much of each element is available to the plant.

After 20 years of research with tobacco, scientists of the U. S. Department of Agriculture have worked out a "key" to deficiencies of nine essential plant nutrients on the basis of certain symptoms evident upon close examination of the leaves, stems and roots of the plant. The "key" in detail is available in a recent Department Bulletin.

Because of its large leaves the tobacco plant was an excellent "first" in the photoperiod field--effect of day length on plant growth. Department scientists believe that it will be another "first" in its role of a plant diagnosing its own nutrition problems. They have found, for instance, that the symptoms for lack of potassium for tobacco and for "potash hunger" of cotton are similar. Other plants may not show these symptoms so readily, but a thorough knowledge of the tobacco plant habits may be the key to nutrient deficiency problems of other plants.

The nine elements considered are nitrogen, phosphorus, potassium, magnesium, calcium, boron, sulphur, manganese, and iron. When an element is deficient, according to Dr. J. E. McMurtrey of the Bureau of Plant Industry, there is not only a reduction in growth of the plant, but a typical reaction. When nitrogen is deficient the plant shows light green color. Also, the lower leaves are yellow, and dry to a light brown color. If it is a lack of phosphorus the plant is dark green, the leaves are narrow in proportion to the length, and the plant remains immature.

Continued on next page

Lack of nitrogen and phosphorus as well as potassium and magnesium affects the older or lower leaves of the plant or it may affect the whole plant. Lack of calcium, boron, manganese, sulphur and iron affects in the initial stages the upper and bud leaves of the plant. Lack of iron, for instance, may be noted as the young leaves are chlorotic or lack green color, the principal veins are darker green than tissue between the veins. When the veins lose their color all of the leaf tissue is white or yellow.

Deficiencies Show at All Growth Stages

In their study with tobacco the Department scientists found that neither the size nor the age of the plant alters the effects due to the deficiency of an element. They may show up at any time from the seedling stage to maturity. Too, they found that when more than one element is deficient there is a greater reduction in growth, although the visible symptoms are those characteristic of the element lacking most.

Doctor McMurtrey believes that once nutrient deficiency problems of plants are solved, the plant--like an animal on a balanced ration--will be in better physical condition and will be more able to withstand the ravages of disease and insect pests.

Once the tobacco grower becomes familiar with these typical symptoms, Doctor McMurtrey says, he can diagnose nutrient troubles right in the field. Because the grower knows the life history of the plant, its growth habits, the diseases and insect pests affecting the crop, he is frequently able to recognize the symptoms better than the specialized scientist who is not so familiar with details of practical plant culture.

MOSQUITO ABATEMENT VERSUS WILDLIFE PRESERVATION STUDIED AND A SOLUTION OF THE PROBLEM SUGGESTED

EDITOR'S NOTE:- There is offered here a basis for the development of a plan which should meet the approval of those concerned with mosquito abatement and those interested in the conservation of various forms of wildlife. Mr. Clarke is the sanitary engineer for The Desplaines Valley Mosquito Abatement District. He presented his views, as given here, in a paper before the Chicago Chapter of the Illinois Conservation Council.

By J. Lydell Clarke,
Lyons, Illinois.

In order for you to appreciate the tremendous popular appeal of mosquito abatement work perhaps it would be well to review what has taken place within the last 25 years. Briefly, the value of mosquito control was recognized shortly after the successful work in Cuba and the Panama Canal Zone. Now seven states have laws governing organization of mosquito abatement districts; California, Florida, Mississippi, New York, New Jersey, Virginia and Illinois; the last named being the only inland state. In these states there are approximately 50 organized districts. Four states, namely; Pennsylvania, Delaware, Utah, Massachusetts, have Commissions or Boards governing mosquito abatement work. Fourteen states in the malaria belt carry on malaria control under direction of the State Boards of Health.

Spraying-Pollution-Drainage

For the purpose of this discussion, the work of the mosquito abatement district may be divided into three phases: spraying mosquito larvacide; combating stream pollution and drainage.

The first phase is that of spraying larvacide on waters actually containing mosquito larvae. Until several years ago, kerosene oil was used; now pyrethrum larvacide is used exclusively. This spray will not harm fish, fowl or foliage and leaves no oil film. There is no complaint as to this practice.

The second phase is that of reclaiming polluted rivers and streams. Mosquitoes do not breed in normal clean streams. Rivers and streams produce mosquitoes in abundance only after fish and other aquatic enemies have been destroyed by pollution. (I have here a whole volume concerning work that the Mosquito Abatement District has done in the interest of clean streams.) On that score, you have not criticized but praised our work.

Continued on next page

The third phase, that of drainage, is the only one which you have questioned critically. I shall, therefore, discuss drainage, as applied to mosquito abatement, comprehensively and in detail.

Classification of Marshes

Marshes fall naturally into three classifications: Permanent Marshes, which hold water at all times; Intermittent Marshes, which are periodically wet and dry; and Temporary Marshes, which are really wet weather pools that hold water for a period of ten days.

When we first started mosquito control work we made no distinction. We drained all marshes. Since that time through experimentation, we have found that the permanent marshes and the intermittent marshes need not be drained. We have learned that it is cheaper to aid and encourage the aquatic enemies of the mosquito in a permanent pond than it is to drain that pond. We have learned too, that an intermittent marsh may be converted into a wildlife oasis; thus bringing about a natural biological balance which will exclude the mosquito.

Aquatic Enemies of the Mosquito

It is a well established fact that the minnows of all fishes feed upon mosquito larvae. Particularly is this true of the top water minnow, Gambusia affinis; which has been introduced recently into waters of this District, and at least one species of the native northern minnow, a dwarf variety of the Sun Fish, Eupomotis gibbosus; but not until recently has full import of aquatic plants and insects been learned. Can it be that insects work where fish cannot? Is that why it is not necessary to drain permanent marshes? These simple experiments will tell the story.

Laboratory Tests - (a) A plant known as Bladderwort placed in a glass bowl containing 1800 small mosquito larvae permitted only three mosquitoes to escape of the 1800. This plant has delicate green foliage. It grows beneath the water surface and shoots yellow blossoms to the surface. It has no roots. It feeds upon insects. Bladderwort is native to this region.

(b) Three larvae of the Water Scavenger beetle (Hyrdophilus triangularis) were placed in a glass bowl containing 3500 mosquito larvae. Only twenty adults emerged.

(c) The Water Tiger, the larva of the Predacious Diving Beetle (Dytiscus hybridus) has a much similar record.

(d) 10 Back Swimmers (Notonecta undulata) ate 4000 larvae in two days.

(e) Four Whirligig beetles (Dineutes assimilis) ate 300 Anopheles larvae in two days.

(f) A jar containing 19 insects in all; Whirligig beetles, Back Swimmers and Dragon-fly nymphs ate 7500 mosquito larvae, permitting only twelve adult mosquitoes to escape.

Continued on next page

A Champaign Pool

Garden Pool Test - Now, let's run this same test in a garden pool. A garden pool in Riverside was filled with water. Ten days later the water was teeming with mosquito larvae. This part of the experiment was to prove that in the absence of plants, fish and insects, mosquito eggs would be deposited on the pond. Having proven this, the larvae in the pool were killed. Then five buckets full of Bladderwort were placed in this pool. Again mosquitoes laid their eggs on the surface of the water. When the eggs hatched and the young larvae dived down to feed, they were entrapped in the vacuum sacks of the Bladderwort. That is, all mosquito larvae except those of the malaria mosquito which swim and feed at the surface of the water. It seemed for a time that our experiment had failed. The Bladderwort could not destroy the malaria mosquito. However, we persisted; we continued the experiment, and seemingly a miracle took place. Insects had been brought in with the Bladderwort. Whirligig beetles appeared on the surface; back swimmers, water striders and water boatmen. Within another week these insects had gained complete control of even the malaria mosquitoes. And that is not all we learned! We learned that a pond controlled by plants and insects is much more attractive than one controlled by fish. There is a more dazzling life about it, more motion, more zest. There are the ripples of the whirligig beetle, the darting and tumbling of the silver-sided back swimmer, and the skipping of the water strider, and the bubbles of the Bladderwort in the sunshine. It is truly a champaign pool if you please.

Field Tests - Now let's take this same experiment to the permanent marshes in the field. What happens there? The same thing, only that which goes on in the permanent marshes is as nature planned it in her great outdoor experiment station where balance is more or less perfect. In the permanent pond fishes feed upon the mosquito larvae in the open water; and along the grassy edges insects destroy all but a negligible few. Therefore, to drain a permanent pond as a means of mosquito control would be foolhardy.

The Intermittent Marsh May Become A Wildlife Oasis

Now, let's take up the second classification, intermittent marshes, and apply this same principle. Marshes with the same growth as those in the permanent ponds; cat tails, sedges and bulrushes. Such marshes are wet only during times of flood. They are wet, say, for a month and dry for a month. On the surface of these marshes mosquitoes have laid their eggs. There are from ten to sixty million eggs per acre lying dormant on the intermittent marshes. When the eggs are covered with water, they hatch immediately and within a period of seven days great grey clouds of mosquitoes arise because the mosquitoes mature faster than any of their enemies. What can be done to control mosquito breeding in intermittent marshes? Simply dig a deep hole where water will remain winter and summer where fish and insects can live. This addition, a water hole, in a parched intermittent marsh is like an oasis in a desert. Because of its isolation and splendid protective covering, birds and animals come to it. It becomes truly a Wildlife Oasis. This method of control is a radical departure--a radical departure in the right direction. We are now experimenting with eight

Continued on next page

Wildlife Oases in our District and plan to have forty such places within the next two years. I want you to see and study them. I want you to see, also, some of the intermittent marshes which have been transformed into lakes and ponds by the building of dams.

The Temporary Marsh

And now we come to the third classification, temporary field pools and wet lots where casual water stands after hard summer rains. If water remains for a period of ten days, millions of mosquitoes will escape in close proximity to the built-up districts, for these field pools are to be found largely in recently developed real estate subdivisions. Once they were well drained farm lands, but subdividers built sidewalks and roads across the original drainage ditches, creating man-made mosquito incubators right in the back yard of the home owner. When these lands were under cultivation, water was not allowed to stand for more than 24 hours. That is a requisite of farm drainage, that water be removed within 24 hours lest crops be injured. Farm drainage is more drastic than mosquito drainage. Mosquito drainage provides that water may stand for five days. If it remains ten days, mosquitoes will take wing. Drainage of this nature constitutes 80% of all drainage done by the mosquito abatement district. We remove the water five days before it would normally dry. Now, does this practice in any way molest or injure wildlife? I wonder! J. Arthur Thompson, in his Web of Life warns us: "Nature has a woven pattern which science seeks to read.....There is a warp and woof in the web.....If one thread be pulled out, many are loosened."

Gross stream pollution in urban districts has wrecked nature's pattern, and large scale agricultural drainage weakened it; but I hold that mosquito abatement and wildlife preservation can be accomplished simultaneously if we but apply ourselves to the task.

The conclusions of the committee as reported in the minutes of the Conservation Council as of October 21, 1937 are as follows:

1. Much mosquito abatement work has been futile and sometimes harmful to wildlife especially aquatic birds.

2. However, such work as that done in the districts supervised by Mr. Clarke and Dr. Meier has been effective and relatively harmless to wildlife.

3. It is important that all mosquito abatement work be under the control of men trained in sanitary engineering and in conservation principles.

Dr. R. M. Strong, chairman of the investigating committee, further said that some of the mosquito abatement work has real value in flood control as temporary marshes and pools are sometimes made permanent by building of dams in order to establish natural mosquito control. Such areas restrain water in flood periods."

Continued on next page

Function of a Wildlife Oasis

Here we are concerned only with the Intermittent Marsh which produces enormous broods of flood-water mosquitoes after every heavy summer rain. The mosquito menace associated with a marsh of this type may be eliminated by digging a central water hole, thus transforming a treacherous intermittent marsh into a Wildlife Oasis.

This central hole is from five to seven feet below the marsh level. It will hold water throughout the dry season. Radiating from this central pond are small fish channels connecting the shallow pools throughout the marsh to this one central pond forming passage-ways along which fishes and aquatic forms of life may retreat as the shallow marginal areas dry out. If deep holes of this sort are provided in large marshes, much of the stench associated with marshes will be eliminated, as the stench is created largely by the decaying of aquatic life as the marsh becomes dry.

During a dry period wildlife of every description may seek cover, find food and a clean water supply. In this oasis during the dry months, the top feeding minnow will become so numerous as to literally crowd the pond with life. When a summer rain fills this pond to overflowing, and extends its surface out into the marsh grasses, minnows will go into the shallow areas to devour the mosquito larvae as soon as hatching occurs. These little fish will go out through the channels to feed in the shallow areas. Again when the marsh begins to dry up, the minnows will retreat to the deep water hole of the Wildlife Oasis where they will remain in safety until another rain floods the marsh. Here we have a perfect example of natural mosquito control and one which promotes the well-being of wildlife.

Within recent years the structure of prairie marshes has changed materially. Orginally they received flood waters from grassy lands, the bottoms building up gradually from dying vegetation. Within recent years they have deteriorated into mud holes by erosion of soil from tilled land. These old marshes may be restored or resussitated by the Wildlife Oasis treatment described above.

Mosquito Control as Related to Marsh Conservation

There is a tendency to confuse agricultural drainage with mosquito control drainage. The distinction is that agricultural drainage has to do with large tracts comprising 9% of all land under cultivation in the United States, while on the other hand, mosquito control drainage is concerned only with the fringe waters. In this District we find that less than 2% of the water surface is suitable for mosquito production. Mosquitoes do not breed in rivers, streams, lakes and ponds where their aquatic enemies abound. Mosquito larvae flourish only when the natural balance of life in these bodies of water is disturbed by excess pollution; or when flood water remains in shallow field pools for more than five days.

With interest in conservation mounting throughout the country and with the realization that the principles of conservation may be utilized to advantage as a means of biological control of mosquitoes, the District staff has directed its efforts toward the development of a plan of mosquito control that will protect rather than destroy wildlife.

Agricultural News Letter (du Pont)
Vol. 7, No. 1, January, 1939

EXPERIMENTAL WORK WITH THE INTRODUCTION OF CHEMICALS INTO THE SAP STREAM OF TREES FOR CONTROL OF INSECTS

EDITOR'S NOTE:- This paper is reprinted by special permission of the authors and Journal of Forestry, Washington, D.C. Part 1 appeared in the December, 1938, issue of the Agricultural News Letter.

By F. C. Craighead and R. A. St. George,
Bureau of Entomology and Plant Quarantine,
United States Department of Agriculture,
Washington, D. C.

Prevention of Insect Attack in Forest Products.--Another objective is the treatment of crude forest products such as poles, posts, and timbers in contact with the ground, and material to be used for rustic work such as furniture, cabins, and bridges, to prevent insect attack and also the shedding of the bark. Untreated poles and posts of many woods placed in the ground are quickly riddled by termites and borers. There are comparatively few termite-resistant woods. Materials used in rustic work such as cabins, furniture, etc., are attacked by bark beetles and the larger borers, and by wood-boring beetles and powder-post insects that loosen the bark and riddle the wood.

For this class of products simple methods are again necessary, and cheapness and thorough impregnation of the sapwood are essential, though more costly methods may be used than in the case of bark beetle control, as the value of the wood is much higher. The chemicals to be used should be both good insecticides and good wood preservatives.

Posts, rustic work, etc., treated with a number of chemicals have now been subjected to service tests for 6 years. These tests indicate that after 6 years in the ground the posts and poles are still in a perfect state of preservation, showing no insect injury or decay. A rustic-work cabin with the logs treated by this method was constructed 2 years ago. Already the untreated check logs are badly damaged by insects and the bark is falling away, while the sticks treated with adequate chemicals show no insect damage, and the bark has remained tight. With such chemicals as copper sulphate and zinc chloride, the standard commercial concentration of 1/2 pound per cubic foot of wood is readily obtained. Other chemicals that have given satisfactory service tests will be mentioned later. Many of these, however, are either dangerous or impractical for various reasons. At the present time the most suitable chemical for these purposes seems to be zinc chloride.

Continued on next page

It should be clearly understood that this treatment for forest products does not take the place of present-day commercial treatments for wood preservation. It is particularly useful for the farmer for treating poles, fence posts, and logs used in the round, for the manufacturer of rustic furniture, or for an individual who, in erecting cabins or other structures, wants to use a small amount of material on which the bark is to be retained.

Control of Shade-tree Insects.--Another objective is the control of insects attacking trees of high aesthetic value, such as trees along streets, in parks, or in recreational areas. Three types of insects are concerned--bark borers, sucking insects, and leaf-feeding insects. As the value of an individual tree is very high, cost is not such a consideration and elaborate technique can be utilized. The chemical, however, must not injure the tree. Here there is a wide field for the biological chemist in developing differential materials that will be toxic to the parasite and harmless to the tree. Working in this field the quack tree doctor often reaps a harvest. Almost anyone is willing to spend 25 cents to several dollars to save a fine shade tree. The usual method employed is to play on the tree owner's credulity, bore a hole in the side of the tree, introduce a pellet, plug the hole, and disappear from the community. The work of the Department of Agriculture with shade trees has not progressed very far. It has developed a technique that will introduce chemicals into the sap stream without unduly injuring the tree, but much work lies ahead on the chemical side of the problem. Thus far no chemicals have been tested that have a sufficiently wide differential in their toxicity to be harmless to the plant and yet destroy the attacking insects.

Methods and Technique

In the first experimental work some 10 years ago attempts were made to introduce chemicals into the sap stream of trees by boring holes into the trunk of the tree at several places around the stem and connecting these with a reservoir containing the chemical solution. Although this method has been recommended in many publications that have appeared from time to time, particularly for use in the treatment of physiological diseases, very little experimental work was needed to demonstrate that it is ineffective when the entire stem of the tree, the branches, and the foliage are to be treated. Inasmuch as there is very little lateral movement of the sap stream within the stem of a tree, a chemical introduced at one point will go up the stem in only a narrow strip and will affect only those limbs directly in connection with the point of inoculation. It soon became evident that it was necessary to introduce the materials around the entire circumference of the tree in order to get adequate and uniform distribution to all parts of the stem and crown.

With this essential requirement determined, a great number of methods have been utilized, among which the following have proved most simple and satisfactory. All methods require that the tree be green and that the crown be left intact during treatment. The simplest method to be used with small trees consists in cutting the tree off at the base and setting it in a pail of solution while the top is lodged against an adjacent tree or otherwise supported. Another method involves the removal of the bark from around the base of the tree, after which a notch is sawn around the tree cutting through several annual layers of wood.

Continued on next page

A wide rubber band is then stretched over this notch and fastened with staples, after which the solution is fed into the notch from a container, suspended above.

A number of modifications of these methods have been tested with varying adaptability to certain trees and purposes. The concentration of the solution seems to be of little importance and only enough water to dissolve the chemical is necessary. For example, a pound of copper sulphate will dissolve in about a half gallon of water. With some salts as little as a pint of water can be used. Recent work is directed at testing the possibility of using the salt dry by merely removing the bark and bandaging the dry salt around the surface of the wood.

Stains have been utilized in many of our early tests so that the movement of the chemical could be followed through the wood. Light green, S.F., acid fuchsin, gentian violet, and many other stains have been tried and, except for special purposes, have been finally abandoned and the distribution of the injected liquid throughout the tree determined by chemical analyses. These stains do not always move at the same rate as the chemicals. They have some use, however, as general indicators of movement.

Species Susceptible to Treatment.--The experimental work has been based on tests with a limited number of tree species, principally pine, spruce, fir, oak, hickory, and yellow poplar. It is quite likely that many other species can be treated effectively by these methods.

Time of Year for Treatment.--Green, healthy conifers can be injected with chemical solutions successfully at any time of the year except during freezing weather. Absorption of the chemicals is, however, more rapid during the growing seasons. Hardwoods will readily take up or absorb the chemical solution during the active growing seasons, commencing when the leaf buds begin to swell. After the leaves have fallen, treatment is possible but much slower and more difficult, and the results may not be so uniformly good.

Time Required for Treatment.--The time required to treat living trees varies to a considerable extent, depending on the physiological activity of the tree, particularly the rate of transpiration. On a bright sunny day a gallon or two of solution will be taken up in 1 to 3 hours, while in cloudy weather or on cool days 24 hours may be necessary. After all of the solution has been absorbed by the tree, the latter should be left for a period of 5 to 10 days to permit thorough distribution of the chemical throughout all parts of the sapwood.

Chemicals Tested for Insect Control

The chemicals listed below have all been tested in this work but will be discussed only briefly at this time, inasmuch as mention has already been made of the requisites of chemicals suitable for injection into the sap stream of trees for insect control and for the preservation of the wood. These chemicals are classified on the basis of results obtained from field tests designed to determine their toxicity to bark-infesting and wood-boring beetles.

Continued on next page

Considering the chemicals as a group, those which were found to be most promising are the first nine listed in the effective column. Of these, all but four are soluble in water in nearly all proportions. Sodium fluoride is soluble only up to 4 per cent at 15° C. (59° F.); sodium arsenate is soluble up to 26.7 per cent at 17° C. (64.6° F.); ammonium copper arsenite and zinc meta-arsenite are practically insoluble in water.

In reference to those chemicals listed as being ineffective, the organic compounds such as orthodichlorobenzene, gasoline, kerosene, and creosote were not suitable for tree injection since they are not readily introduced into the sap stream of the tree. Crude pyridine, listed among the effective chemicals, was absorbed very slowly.

The chemicals that act as fumigants, and the alcohols, although temporarily effective against broods of bark beetles in freshly attacked trees, are of no value as wood preservatives, since wood-infesting borers and fungi attack the tree or wood a short time after it has been treated.

Even the most promising chemicals have some disadvantages. As previously intimated, zinc chloride and copper sulphate (blue vitriol) are probably the most satisfactory, considering all requisites. Copper sulphate is the cheapest and, except for its corrosive action on metals, is nearly ideal. Zinc chloride is slightly corrosive when in contact with metals but not enough so to be of any consequence. Further, it has been noted on rare occasions that some of the cheaper grades of zinc chloride contain residual matter which forms a rather heavy precipitate when dissolved in water. Such precipitate has been known to form a thick slime-like mass in the kerf and to interfere somewhat with conduction. At such times the addition of acetic acid to the precipitate aids in clearing the solution.

Effective for Insect Control

Zinc chloride
Copper sulphate (blue vitriol)
Mercuric chloride (corrosive sublimate)
Zinc meta-arsenite
Sodium arsenate
Sodium arsenite
Sodium fluoride
Ammonium bifluoride
Ammonium copper arsenite
Sodium borate
Sodium nitrate
Potassium nitrate
Pyridine (crude)
Ethylene dichloride
Formaldehyde
Ethyl alcohol
Methyl alcohol
Butyl alcohol
Potassium cyanide
Hydrocyanic acid
Carbon disulphide
Ether

Ineffective

Sodium sulphide
Potassium dichromate
Ethyl mercuric chloride
Ethyl mercuric sulphate
Chromic acid
Picric acid
Orthodichlorobenzene
Gasoline
Kerosene
Creosote

Continued on next page

Comparison of Old and Modern Methods

A perusal of the preceding discussion of our technique and a review of the literature of older work immediately raise the question as to present progress. As a matter of fact, Boucherie more than 50 years ago had overcome all the practical difficulties in the introduction of chemicals into the sap stream of trees. The writers have completely paralleled his work, not knowing the details of his method until 2 years ago. Present technique is an improvement over that of Boucherie only in that today superior materials are available. This work of Boucherie was lost sight of largely because of the development of modern machinery for treating wood with wood preservatives. Impregnation for the preservation of wood from decay was Boucherie's chief objective; he was not concerned with prevention of insect damage as such.

It would appear that the chief essentials in introducing chemicals into the sap stream of trees for insecticidal purposes are (1) to see that the solution is in contact with practically all the conducting vessels of the tree, and (2) that the crown of the tree is left intact and actually functioning. This latter, of course, means that when the foliage is present, and active transpiration is under way, the chemicals are most readily absorbed. Apparently these features have been overlooked or not given sufficient attention by workers of the past 20 years.

In presenting this review of the experimental work of the Division of Forest Insect Investigations, Bureau of Entomology and Plant Quarantine, the writers by no means intend to imply that this method is a cure-all for all sorts of insect attack on forest and shade trees, or that it can in any way take the place of modern methods of commercial treatment of timbers for the purpose of wood preservation. It has, however, very distinct possibilities in bark beetle control, in the prevention of insect attack to crude forest products, particularly for the farmer in the case of poles and fence posts, or for the individual who wants to erect a rustic cabin; and future work may show that it has advantages in the control of shade-tree insects, although results up to the present have been distinctly negative.

Literature Cited

1. Bonnet, C. 1754. Recherches sur l'usage des feuilles dans les plantes. 343 pp., illus. Gottingen and Leiden.

2. Buffon, G. L. L. 1755. Histoire naturelle des arbres.

3. Cotta, H. 1806. Naturbeobachtungen uber die Bewegung und Funktion des Saftes in den Gewachsen. 96 pp., illus. Weimar.

4. Hales, S. 1735. Statique des végétaux.

5. Lipowitz. 1841. Anleitung zur Konservation des Holzes nach Boucherie.

Continued on next page

6. Metzger, R. 1927. Baume werden gegen Krankheiten geimpft. Die Umschau 31: 666-667, illus.

7. Mokrzecki, S. A. 1903. Uber die innere Therapie der Pflanzen. Zeitschr Pflanzenkr 13: 259-265, illus.

8. Moll, F. 1915. Die Impragnierung des Holzes. Chemische Apparatur 2: 49-53, illus.

9. Muller, A. 1926. Die innere Therapie der Pflanzen. Monographien zur Angewandten Entomologie 8: 1-206, illus. bibliog.

10. Rumbold, Caroline. 1913. Report of the physiologist. Report of the Penn. Chestnut Tree Blight Comm., July 1-Dec. 31, 1912, pp. 45-47, illus.

11. --------. 1915. Methods of injecting trees. Phytopath 5: 225-229, illus.

12. --------. 1920. The injection of chemicals into chestnut trees. Amer. Jour. Bot. 7: 1-20.

13. --------. 1920. Giving medicine to trees. Amer. Forest. 26: 359-362, illus.

14. Sachs, J. 1875. Geschichte der Botanik. 522 pp.

15. Saussure, Theod. De. 1804. Recherches chimiques sur la vegetation. 327 pp., Paris.

Agricultural News Letter (du Pont)
Vol. 7, No. 1. January, 1939

AN IMPROVED FUNGICIDE FOR TREATING NEWLY SAWN LUMBER TO PREVENT "BLUE STAIN" IS EXPECTED TO EFFECT SAVINGS

EDITOR'S NOTE:- The development of an improved fungicide for treating lumber is of economic importance not only to the lumber industry but also users of lumber. Improvement is often as important a function of research as are discovery and invention.

By C. E. Graves and Lucile Nelson,
Grasselli Chemicals Department,
E. I. du Pont de Nemours & Co., Inc.,
Wilmington, Del.

More effective and permanent control of the fungi causing the unsightly "blue stain" in freshly sawn lumber, which is promised by a new disinfectant chemical announced by E. I. du Pont de Nemours & Company, may save the lumber industry sums of money running into millions of dollars. By increasing the availability of bright lumber, use of the new chemical is expected to contribute materially to the national building program.

The product is to be called New Improved "Lignasan" Fungicide, according to the announcement, and will be made available to lumber producers immediately. Its introduction follows over a decade of research. In extensive field tests conducted for two years under conditions conducive to the development of sap-stain fungi, the new product proved superior to any other compound tested.

"Blue stain" or "sap stain" has long been the bane of the lumber industry, according to forestry experts. Scientists have proved that it is caused, not by "souring" of the sap, as was popularly believed some years ago, but by fungi which obtain their nourishment from the material stored in the cell cavities of the sapwood. The objectionable bluish to bluish-black color of stained wood is caused by the massing of the dark colored hyphae or threads of the fungi within the relatively light colored wood.

"Blue stain" may develop in the sapwood of susceptible woods, including pine, sapgum, poplar, magnolia, maple, tupelo, beech and hemlock, at various stages in lumber manufacture, during storage or transportation, or even in the finished product, when the moisture content is above 25 percent. However, freshly sawn lumber is the most liable to attack by the sap-stain fungi, and it is during the early part of the seasoning process that most trouble is encountered. Since infection is most severe under conditions of high humidity and temperature, sap-stain is of especial economic importance in southern lumbering operations.

Continued on next page

Heavy Loss to Lumber Industry

Prior to 1928, when organized research was directed against the problem, it was estimated that sap-stain cost the lumber industry in excess of $10,000,000 every year. Sap-stained lumber frequently sells at a differential of $2 to $3 per thousand board feet less than bright lumber. Discriminating builders have always preferred the bright lumber, and for many purposes where a natural finish is involved the use of stained wood is automatically ruled out. The loss is not only in money to the lumber manufacturer, but also to the general public in the reduced availability of good lumber and the unprofitable drain on the forests.

Preventive measures for sap-stain in air-dried lumber prior to 1928 consisted of such difficult expedients as steaming, end racking, and dipping the lumber in hot soda solution. In addition to the nuisance of keeping the solution hot, this treatment was objectionable because it discolored the lumber, was limited to pine in usefulness, and lacked uniform control even on pine.

"Lignasan" Fungicide Developed

Recognizing the need for an efficient and practical disinfectant for air-dried lumber, the du Pont Company developed the product called "Lignasan" Fungicide, which was introduced in 1930 after two years of careful research in cooperation with lumber manufacturers and Department of Agriculture forest pathologists. "Lignasan" was the first of modern anti-stain chemicals, which have won such rapid acceptance in the lumber industry that, it is estimated, 60 to 80 per cent of the susceptible species of air-dried lumber are dipped in anti-stain chemicals at the present time. Improved piling practices have been worked out to enhance the efficacy of chemical treatment.

In spite of the large measure of sap-stain control afforded by the first "Lignasan," du Pont research workers have kept at the problem, constantly seeking to better the product and increase the efficiency of the treatment under most severe conditions. For instance, if a fog hangs over the stacked lumber day after day, keeping the wood saturated with moisture in warm weather, the anti-stain chemical must be of extraordinary efficiency and permanence to give lasting protection. Export shipments of lumber demand similar prolonged effectiveness.

Since the introduction of the older type "Lignasan," du Pont chemists and forest pathologists have tested hundreds of chemicals against stain fungi. Those giving most promising results in the laboratory have been tested in the field under commercial operating conditions. During ten years of such research work, the experimental compound "Grasselli IN-1756," now being offered as New Improved "Lignasan," was the first and only one to show consistently better control of sap-stain than the older type of "Lignasan."

Continued on next page

New Improved "Lignasan"

The new product contains ethyl mercury phosphate, which is one of the most powerful fungicides known, and a specific against the fungi that cause sap-stain. These properties of ethyl mercury phosphate have been known for several years, but the practical use of it as an anti-stain agent awaited the discovery by du Pont chemists of a formulation taking advantage of certain carrier materials to increase its permanence and prolong the period of its effectiveness.

Greatest differences in favor of New Improved "Lignasan" were noted under more severe conditions -- that is, when excessive warmth and humidity prevailed. In every field test except one, it gave a significantly higher degree of sap-stain control than any compound with which it was compared. In the single test excepted, neither New Improved "Lignasan" nor the product with which it was compared permitted the occurrence of any stain.

New Improved "Lignasan" is conveniently applied from water solution. It is non-corrosive to iron or steel, and does not cause objectionable discoloration of lumber. The solution in the strength recommended for dipping lumber has not proved irritating to the skin of workmen handling the dipped lumber.

"Lignasan" is a trade-mark registered in the United States Patent Office by E. I. du Pont de Nemours & Company, Wilmington, Delaware.

##########